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Eight Naval Postgraduate School students from physics coursePH4055 will soon see what scientific and industrial research is like at its best. NPS Distinguished Professor of Physics Bill Colson and his students will participate and share in the studies behind what the Navy and industry experts say will be the weapon of the future.

More than 100 participants from the Navy, industry, universities, and national laboratories will attend this two-day workshop held June 5 and 6 in Newport News, Va. Many of the concepts for the one-megawatt Free Electron Laser (FEL) were developed at a workshop held at Thomas Jefferson National Accelerator Facility about five years ago attended by several NPS students, said Colson.

When Colson arrived here at NPS in 1989, the Strategic Defense Initiative Organization, which tracks today's major news on the Ballistic Missile Defense, was just beginning to wind down. The FEL was the main weapon of interest in an ambitious program to research a weapon that could shoot down thousands of missiles at enormous ranges.

Commander in Chief of the Atlantic Fleet Admiral Robert J. Natter said in a letter to the CNO recently, "Such a laser weapon would offer our Naval forces an extremely versatile weapon to counter numerous soft and hard targets. A high laser weapon can be designed to deliver energy that can track, warn, damage, mission kill, and if need be, destroy a threat.

"I believe it is exactly this type of weapon system that our forces need in the littoral environment where, even though the threat may not always be as sophisticated as a highly maneuverable cruise missile, intentions are often more difficult to listen and timelines are extremely short.

"It is my hope that we can move quickly toward developing, demonstrating, and acquiring an effective laser weapon system for our forces," said Natter. "I request, therefore, that we pursue this technology aggressively."

Colson and his students are doing just that as they emphasize the changing Navy mission. "No longer is it the mission of the Navy to be able to take out a grid square from many kilometers out at sea. The Navy has to be in the littorals. We have to be able to identify and takeout pinpointed targets - often times targets that are surrounded by civilians."

He admits the whole system is extremely ambitious. "Since the beginning of the FEL development in the 1970's, we had known the FEL could operate at high power levels. The laser interaction volume that contained only a relativistic electron beam, a static magnetic field, and laser light could not be damaged and was transparent to all optical wavelengths. Intense electron beams could burn through tens of feet of steel in seconds."

With this type of power and pinpoint accuracy, Colson said this will not only enable the Navy to accomplish the brown water missions that are needed today, it will allow those ships to maintain a presence close to the shore of a hostile nation.

"We do not have enough defensive weapons that allow us to keep our presence in the littorals," he said. "We have plenty of offensive weapons that we can use to take out a large number of hostile targets, but that is increasingly becoming further away from the type of mission Navy ships deploy for. This laser will enable us to maintain our presence in those hostile areas."

Colson said that this type of defense is popular in the American culture. "If you'll remember those old John Wayne cowboy movies where the Duke would allow his enemy to draw his gun first - then he would quickly pull his six-shooter and shoot the other guys weapon out of his hand. This is the type of characteristic the FEL gives the Navy."

The FEL converts the energy of the electron beam into light, which then could propagate through the atmosphere to targets at great distances. The biggest thing Colson said researchers are tackling right now is how to make this laser powerful and compact enough to fit on a ship.

The Simulation of Physical and Weapon Systems course starts with simulations of the Navy's PHALANX gun and follows the trajectories of what Colson calls penetrators, which include the effects of gun dispersion,

The desired result is destruction of missile guidance systems, ignition of the missile fuel or warhead, or structural damage that causes the visible break up of the missile at ranges of five-kilometers out so the debris does not reach the ship.

"The students and I were surprised to find that the PHALANX does not destroy missiles sufficiently far enough away from the ship to protect the ship and Sailors from serious damage and injury," said Colson. "There are many things on ships that will burn or explode when hit by a high velocity projectile."

"Even worse, in the early 1990's, the Navy was moving to littoral missions where missiles could be launched from relatively short range," Colson pointed out. "The Navy needs an effective and surgical defensive weapon against short range missiles that allows that ship to remain in the brown water."

Colson says it has become clear recently that the Navy may need to defend ships against small watercraft without having to worry about the danger of exploding warheads near civilians. Although, he said the PHALANX gun has decades of use in the Navy, and the FEL is many years away from possible deployment on ships.

"I'm advocating the FEL as a future weapon, but I'm thinking that the future may not be a long way off," stressed Colson. "Two other important developments were occurring simultaneously during the early 1990's. I was able to get the Navy interested in FELs through John Albertine, director of the Navy's High Energy Laser Directed Energy Office in Washington D.C., and the Director of the FEL Program at Thomas Jefferson National Accelerator Facility Dr. Fred Dylla."

Colson said Albertine has constructed and has been able to shoot down missiles with a chemical laser at White Sands Missile Range in New Mexico. "I was surprised to hear him recommend that FELs were the best solution for directed energy because it could be designed to operate at a wavelength that would better propagate through the atmosphere," said Colson.

This led to a proposal to build a FEL at the newly formed national laboratory in Newport News, now called the Thomas Jefferson National Accelerator Facility. This FEL project was to be used for industrial processing to create the intense, relativistic electron beam.

This design planned for the re-circulation of the electron beam back through the accelerator to recover beam energy. With its high efficiency, reliability, and compactness, the Thomas Jefferson FEL has many of the characteristics needed for shipboard weaponry, said Colson.

"Dr. Fred Dylla, Director of the FEL Program at Thomas Jefferson, asked whether I had any contacts in the Navy interested in Directed Energy," explained Colson. "I introduced Dylla to Albertine, and money was found to construct a new building at Thomas Jefferson housing the super-conducting, re-circulating FEL.

"Dr. George Neil was hired at Thomas Jefferson because he has worked on FELs and high power lasers before," said Colson. "We started a collaboration involving NPS students that has lasted over 10 years now." Colson said NPS simulated the Thomas Jefferson FEL before it was built and continues to contribute to its development. "At present, the Thomas Jefferson FEL is the most powerful FEL in the world operating at about two-kilowatt average power for many hours at a time.

"We are actively working with Thomas Jefferson on plans to upgrade to 10 kilowatts in the near future and then on to a 100kilowatts power level," said Colson. "It has become increasingly clear that the Thomas Jefferson FEL features can be made more compact, efficient, and reliable as we work towards the one-megawatt power level needed for ship defense applications."

Editor's note: The current issue of the Naval Postgraduate School Research Review has an in-depth technical article on the Free Electron Laser project.

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